DOCUMENT RESUME

ED 392 638 SE 057 968

AUTHOR Camp, Carole Ann, Ed.
TITLE Invitations to Evolving. Teacher-Friendly Science Activities with Reproducible Handouts in English and Spanish. Grades 3-5. Living Things Science Series.
REPORT NO ISBN-1-886172-11-0
PUB DATE 95
NOTE 50p.; For other booklets in the series, see SE 057 967-972.
AVAILABLE FROM Ash Grove Press, Inc., 19 Elm Street, South Deerfield, MA 01373 ($5.95 single copy sold separately; $29.95 set of six, plus shipping and handling).
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052) -- Guides - Classroom Use - Instructional Materials (For Learner) (051)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Biology; Elementary Education; *Evolution; Paleontology; *Science Activities; Science Instruction; Worksheets
IDENTIFIERS American Association for Advancement of Science

ABSTRACT

This booklet, one of six in the Living Things Science series, presents activities about evolution which address basic "Benchmarks" suggested by the American Association for the Advancement of Science for the Living Environment for grades 3-5. Contents include background information, vocabulary (in English and Spanish), materials, procedures, extension activities, and worksheets. The worksheets are presented in both English and Spanish versions. Suggestions for use of the activities include using student grouping, a related readings center, and journal keeping. Activity names are: "Homo Sapiens"; "Cats, Dogs, Birds, and Fish"; "Characteristics for Survival"; "Hide and Seek"; "Fossil Models"; "Digging Fossils"; "Bones, Bones, and More Bones"; "Then and Now"; "Where Did That Come From?" "and "Time Travel." Lists of fiction and non-fiction readings are included. (MKR)

INVITATIONS

TO

Evolving

Teacher-Friendly Science Activities

with reproducible handouts in English and Spanish

Grades 3-5

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LIVING THINGS SCIENCE SERIES

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Life's Diversity

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Cells: Life's Building Block

Interdependence: Caught in the Web

The Matter-Energy Cycle

Evolving

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ISBN: 1-886172-11-0

Printed in the United States of America

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ACKNOWLEDGMENTS

The editor acknowledges the help of many people, especially the teachers in "Science In The Elementary Classroom" at Eastern Connecticut State University, who contributed many of their ideas and whose names are listed on the title page. In addition Ash Grove Press would like to thank our readers: Joan Langley and Katie Tolles and our translator, Deb Gonzalez. We would also like to thank Stephen Lobo for vital technical and emergency computer assistance.

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INVITATIONS TO EVOLVING

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

INTRODUCTION

Evolution is the gradual change from one form to another. Geologic evolution is the process the earth has undergone. Organic evolution is the continuous change that has occurred in living things.

Charles Darwin is credited with explaining evolution through the process of natural selection. Natural selection is the mechanism for the historic changes that lead to evolution. Environmental changes can lead to changes in species based on natural selection. These eventually lead to evolutionary changes.

Fossils tell us the history of plants, people, and animals that lived long ago. Some of these organisms are similar to organisms on the planet today, and some are quite different.

The concepts listed above are addressed by the invitations in this book. Due to the nature of the interdependence of all things, some activities address aspects of one or more of these concepts and are highlighted by bold print in the concept section of each Invitation. The concepts in this invitation address the ones suggested by the American Association for the Advancement of Science for the Living Environment for grades 3-5. In addition, these invitations help students begin to understand that gradual change has taken place on the earth for a very long time.

SCIENCE JOURNAL

Encourage students to keep journals of their observations and to reflect on these observations as they struggle with the concepts of evolution. The students can create their own format for their science journals, the teacher can suggest a format, or the reproducible pages at the end of this book may be used.

CLASSROOM MANAGEMENT

The activities in this *Invitation* can be managed in a variety of ways. Students should have many opportunities to work together in groups of 3-4 students. By sharing and working together, students will be able to value their fellow students contributions, as well as begin to realize that the process that they are experiencing is similar to the way scientists work.

If it is possible in your classroom, identify one area, desk, or table, as "Invitations to Evolving." In this center include books from the resource list and extension activities.

Some aspects of these *Invitations* are more appropriate for the younger students, while other aspects are better for older students. Teachers should feel free to adapt each activity for their particular students

RELATED READING FOR INVITATIONS CENTER

Non-fiction

Arnold, Caroline. *Dinosaur Mountain, Graveyard Of The Past*. New York: Holiday House, 1990.

Bender, Lionel. *Animals of the Night*. New York: Watts, 1989.

Berger, Melvin. *How Life Began*. New York: Doubleday, 1991.

Bright, Michael. *Tropical Rainforest*. New York: Gloucester Press, 1991.

Cole, Joanna. *Evolution*. New York: Harper Trophy, 1987.

Eldredge, Niles, et. al. *The Fossil Factory: A Kid's Guide to Digging Up Dinosaurs, Exploring Evolution And Finding Fossils*. illus., Kelley True and Steve Lindblom. Reading, MA: Addison Wesley, 1989.

Facklam, Margery. *And Then There Was One*. San Francisco: Sierra Club Books, 1990.

Freedman, Russell. *They Lived With The Dinosaurs*. New York: Holiday House, 1990.

Guiberson, Brenda Z. *Spoonbill Swamp*. New York: H. Holt & Co., 1992.

Helmsley, William. *Jellyfish to Insects: Projects With Biology*. New York, Watts, 1991.

Jaspersohn, William. *How the Forests Grew*. New York: William Morrow & Co., 1980.

Kirkpatrick, Rena K. *Look At Shorelife* Milwaukee: Raintree Press, 1985.

Lampton, Christopher. *Endangered Species*. New York: Watts, 1988.

Lasky, Kathryn. *Dinosaur Dig*. New York: Morrow Junior Books, 1990.

Lauber, Patricia. *Summer of Fire*. New York: Orchard Books, 1991.

Lauber, Patricia. *Living With Dinosaurs*. New York: Bradberry Press, 1991.

Lindsay, William. *Barosaurus*. New York: Darling Kindersley, Inc., 1992.

McMullan, Kate. *Dinosaur Hunters*. illus., John R. Jones. New York: Random House, 1985.

Matthews, Ruppert. *The Age of Mammals*. New York: Watts, 1990.

Mitchell, Andrew. *Wildlife Of The Rainforest*. New York: Mallard Press, 1989.

Moody, Richard. *Prehistoric Life*. New York: Exeter Books, 1983.

Pohl, Kathleen. *Sunflowers*. Milwaukee: Raintree Press, 1987.

Sovak, Jan. *Prehistoric Mammals*. New York: Dover Publications, 1991.

Stone Lynn M. *Wetlands*. Vero Beach, FL: Rourke Corp., 1989.

Time-Life Books. *The Human Dawn*. Alexandria, VA: Time Life Books, 1990.

RELATED READING FOR INVITATIONS CENTER

Fiction

Adler, David A. *Cam Jansen And The Mystery Of The Dinosaur*. illus., Susanna Natti. New York: Viking, 1981.

Anker, Charlotte. *Last Night I Saw Andromeda*. illus., Ingrid Fetz. New York: H.Z. Walck, 1975.

Boston, L.M. *The Fossil Snake*. illus., Peter Boston. New York: Atheneum, 1976.

Brett, Jan. *The First Dog*. New York: Harcourt Brace Jovanovich, 1988.

Carrick, Carol. *Big Old Bones: A Dinosaur Tale*. illus., Donald Carrick. New York: Clarion, 1989.

Cohen, Miriam. *Lost In The Museum*. illus., Lillian Hoban. New York: Greenwillow, 1979.

Cole, Sheila. *The Dagon In the Cliff: A Novel Based On The Life Of Mary Anning*. illus., T.C. Farrow. New York: Lothrop, 1991.

Conrad, Pam. *My Daniel*. New York: Harper Collins, 1989.

Denzel, Justin. *Land Of The Thundering Herds*. illus., Brent Watkinson. New York: Philomel Books, 1993.

Forenan, Michael. *Dinosaurs and All That Rubbish*. New York: Thomas Y. Crowell, 1973.

Kellogg, Steven. *Prehistoric Pinkerton*. New York: Dial Books for Young Readers, 1987.

Kraus, Robert and Bruce Kraus. *The Detective Of London*. illus., Robert Byrd. New York: Windhill Books, 1977.

Lowry, Lois. *The One Hundreth Thing About Caroline*. Boston: Houghton, 1983.

Platt, Kin. *Darwin And The Great Beasts*. New York: Greenwillow, 1992.

VOCABULARY

The teacher is encouraged to help students develop their own unique set of vocabulary words depending on the student's interest, experience, and ability. The following words are primarily for the teacher.

adaptation: the process by which a species becomes better suited to its environment

adaptive radiation: the spreading out of a population through adaptation to occupy different environments

adaptive behavior: particular behavior that insures the well-being of an animal.

biogenesis: a scientific principle that life arises from life

cladogram: a diagram which shows the evolutionary relationship among organisms

coevolution: the process by which two or more species evolve in response to each other.

convergent evolution: the process by which different organisms develop similarities.

evolution: the slow process by which organisms genetically change over time.

natural selection: the process by which organisms survive and adapt to their environments

order: a group of similar families of organisms

organism: a living thing

primate: order to which animals such as humans, apes, monkeys and prosimians belong.

species: a group of organisms that can interbreed with each other and produce fertile young.

vestigial organs: organs which are functionless as a result of poor development.

adaptación: el proceso por el cual las especies se ajuten a su medioambiente

radiación adaptativa: la difusivación de una población por medio de adaptación para así ocupar diferentes ambientes

comportamiento adaptativo: comportamiento particular que asegura el bienestar de un animal

biogénesis: un principio científico que estipula que la vida surge de la vida

cladograma: diagrama que demuestra las relaciónes evolucionares entre los organismos

coevolución: el proceso por el cual dos o más especies evolucioen en respuesta de cada cual

evolución convergente: el proceso por el cual diferentes organismos desarrollan similaridades entre sí

evolución: el proceso lento por el cual los organismos cambien genéticamente através del tiempo

selección natural: el proceso por el cual los organismos sobreviven y se adoptan a sus medioambientes

orden: un grupo de familias d organismos similares

organismo: un ente viviente

primado: orden al cual animales tales como humanos, simios, monos y prosimios pertenecen

especies: un grupo de organismos que peuden procrearse entre sí y que producen hembras fértiles

organos degenerados: organos que no funcionan a causa de un desarrollo inadecenado

INVITATION 1

Homo Sapiens

CONCEPTS

- **Individuals of the same kind differ in their characteristics.**
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

BACKGROUND

As life evolved on earth, more and more different organisms emerged. Over the centuries, scientists have developed a variety of ways to classify the 1.4 million possible species that are now thought to exist.

One of the present systems has human beings classified in the following way:

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primates
Family	Hominidae
Genus	Homo
Species	Homo Sapiens

Charles Darwin believed that the classification system provided evidence to support evolution. One aspect of the theory of evolution suggests that organisms that are similar share common ancestors.

A species is a group of organisms that are very similar and can produce fertile offspring. Most species cannot produce fertile offspring with other species. However, an exception is the offspring of dogs and wolves.

Members of a species share at least one inherited characteristic not found in other organisms. There are also a great many variations within the species. Polar bears, for example, have white hair that helps them survive in the snowy tundra. All human beings belong to the species Homo Sapiens, but each human being is also unique. One contributing factor for these differences is environmental conditions.

In addition to the concept highlighted for this Invitation, the authors hope that this Invitation will help students appreciate and affirm diversity.

MATERIALS

- newsprint
- magic markers for each group

PROCEDURE

1. In small groups, have students brainstorm a list of characteristics that are true for all Homo Sapiens. When the list is completed, have students note in another column the variations found in each of these characteristics. For example, Homo Sapiens have two eyes, but eye color differs. All Homo Sapiens have hair on their heads, but colors differ, and amount of curl differs. All Homo Sapiens are covered with skin, but skin color differs. See sample on next page.

2. When groups have finished, have each group share its list with the class.

3. Help students refine the list until about 10 characteristics and their variations can be agreed upon by the class.

4. Select 4 or 5 from the list. For each one, list the variations possible. For example, eye color: blue, black, brown, hazel, green, gray, amber. If a trait selected is continuous like height or weight, suggest discreet categories. For example, height: 27-30 inches, 31-34 inches, etc.

5. In a large space in your room or on the playground, and using the selected categories from step #4, have students gather in groups according to category. For example, students with blue eyes in one group, brown eyes in another, etc. Count the number in each group and record on board or newsprint.

6. Regroup according to variations for another trait. Record numbers.

7. Calculate the percentage of students in each sub-group.

8. For discussion: Will the percentages hold for a larger group? For example, if 50% of the students have blue eyes will 50% of the people in the school, town, country, world have blue eyes?

9. Have students create a data collection sheet that will help them sample a larger population. For younger students 3-5 traits will be enough. For older students you many want to try more.

10. When survey forms have been refined, have students survey other people in the school. (Remind them not to interview participants that already have been surveyed!)

11. Pool the class data. Calculate percentages. Discuss results.

HOMO SAPIENS

True for all Homo Sapiens	Variations
Two eyes	colors: hazel, blue, black, brown, green, amber, gray
Hair on head	colors: brown, red, blond, black, auburn, gray, white amount of curl: straight, tight curls, wavy
Covered by skin	colors: brown, black, sand, pink, olive, tan, beige, tawny, bronze, ivory, fawn, mocha, freckles:

INVITATION 2

Cats, Dogs, Birds, And Fish

CONCEPTS

- **Individuals of the same kind differ in their characteristics.**
- **Sometimes the differences give individuals an advantage in reproducing and surviving.**
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- **Some organisms that lived long ago are similar to existing organisms, but some are quite different.**

BACKGROUND

The classification system proposed by Carolus Linnaeus is based on the fact that there are different degrees of similarity among organisms. Mountain lions resemble house cats, but not guppies. He believed that the similarities exist because the organisms descended from a common ancestor. In evolutionary history, the more two organisms are similar, the more recently they shared a common ancestor. The ancestor of a house cat diverged from the mountain lion a few million years ago, while the ancestor of the cat and the ancestor of the guppy probably diverged about 390 million years ago.

MATERIALS

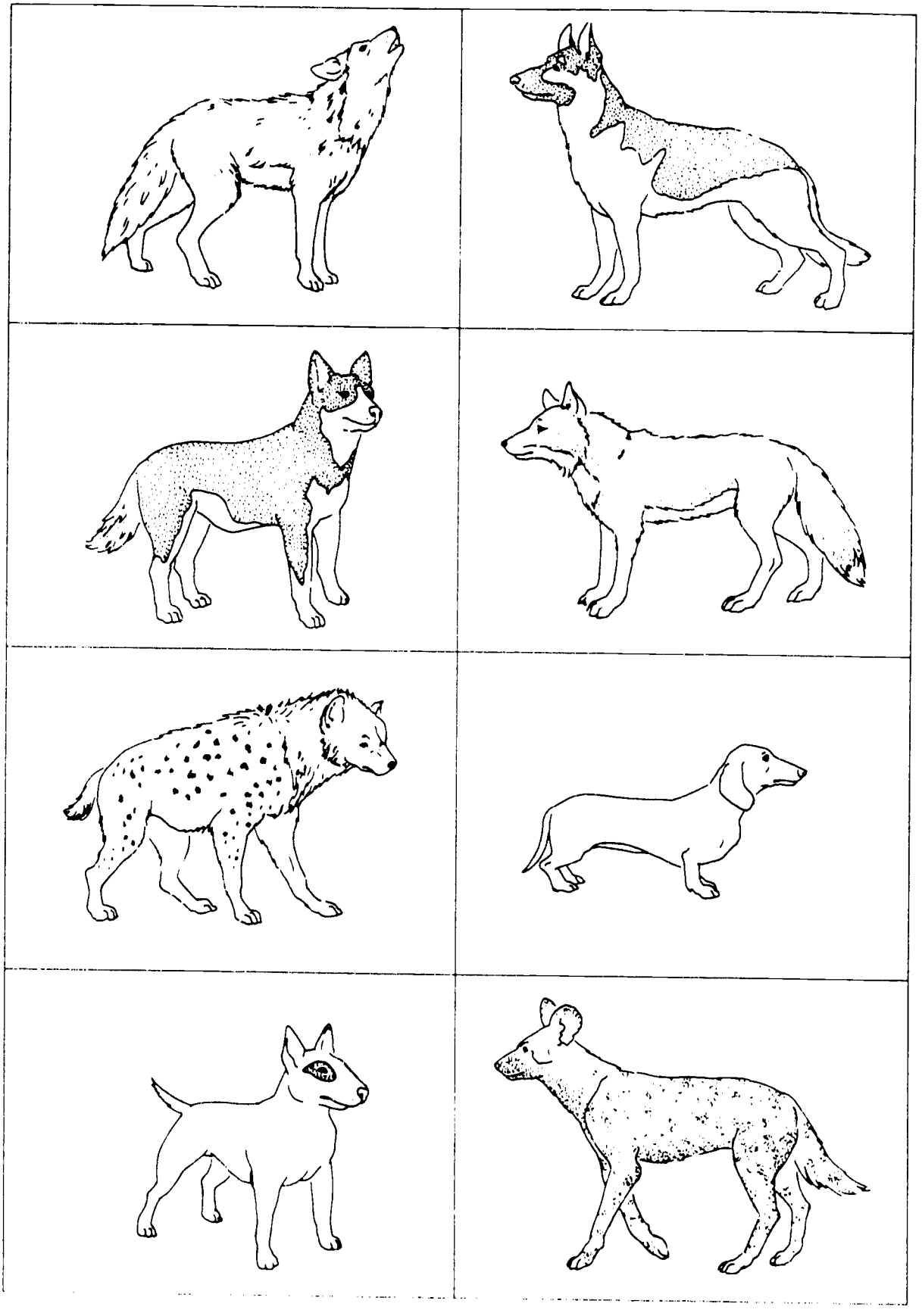
- pictures of cats, dogs, birds, fish, as many varieties as possible or enlarge pages 8-11.
- science magazines with pictures of dogs, cats, birds, and fish that can be cut up

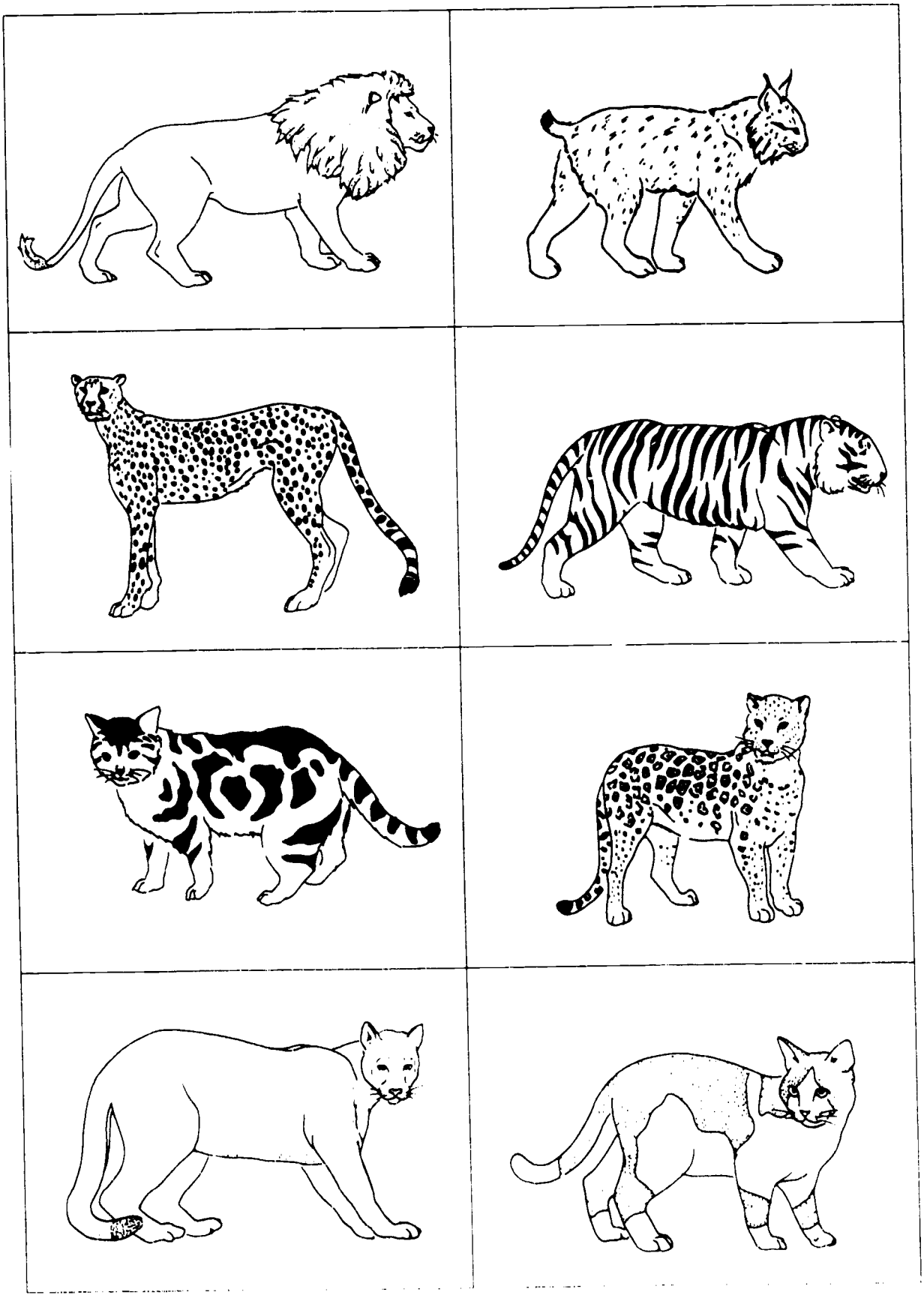
PROCEDURE

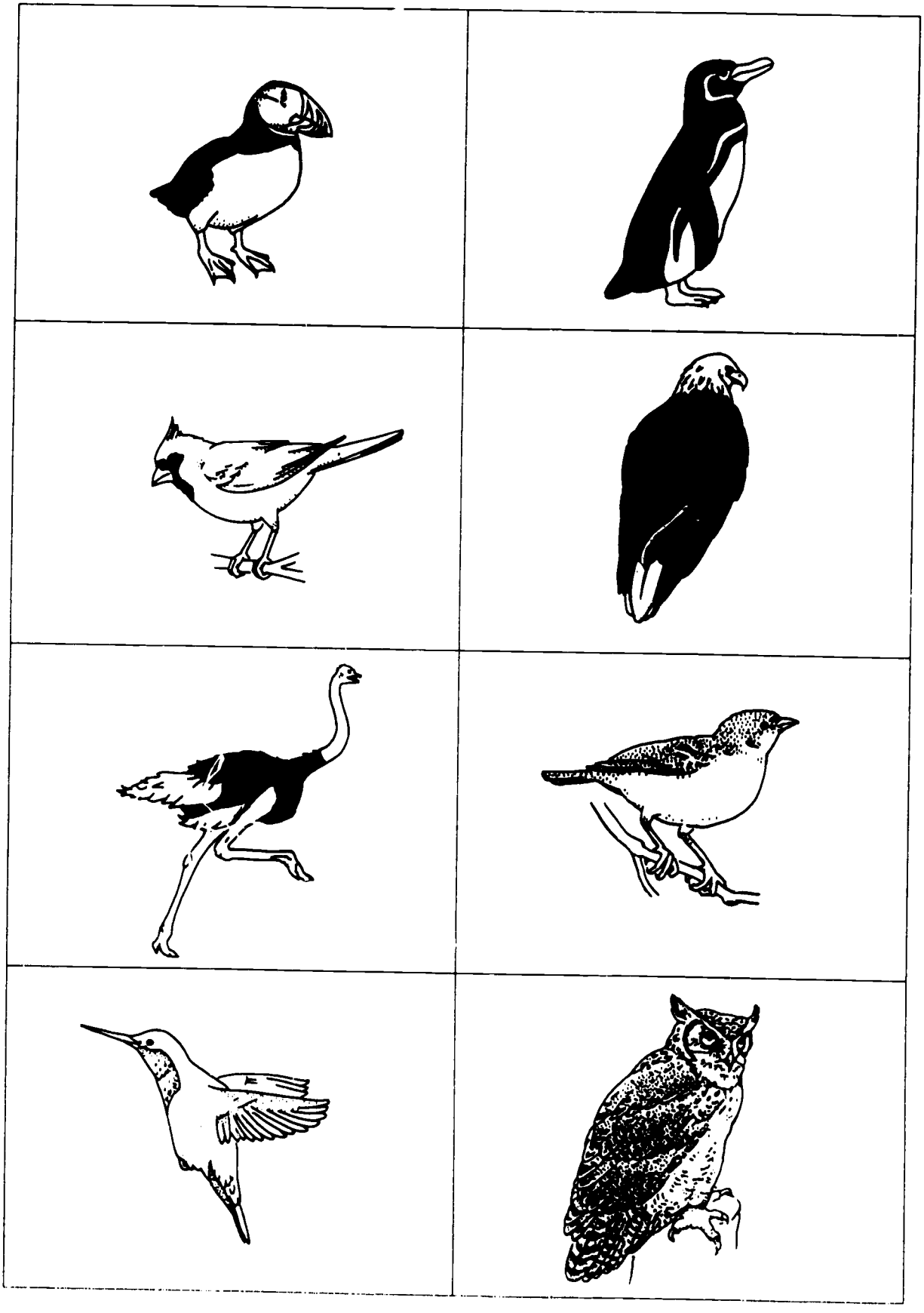
1. Divide class into 4 groups: cats, dogs, birds, fish. Give the set of dog pictures to the dog group, etc.
2. Have students list similarities and differences found within the set of pictures for their group.
3. Invite students to find pictures of other animals that belong to their group.
4. In journals, have students reflect on how the differences within that particular group help that animal survive. Share reflections within their group.
5. As a class discuss the differences between dogs and cats, cats and fish, etc.
6. Research ancestors of each group. For example, some scientists believe dinosaurs are ancestors to birds.
7. In journals, reflect on how the differences between the ancestors and the descendants have evolved. How have the changes helped the animal to survive? What may have happened that caused the changes?

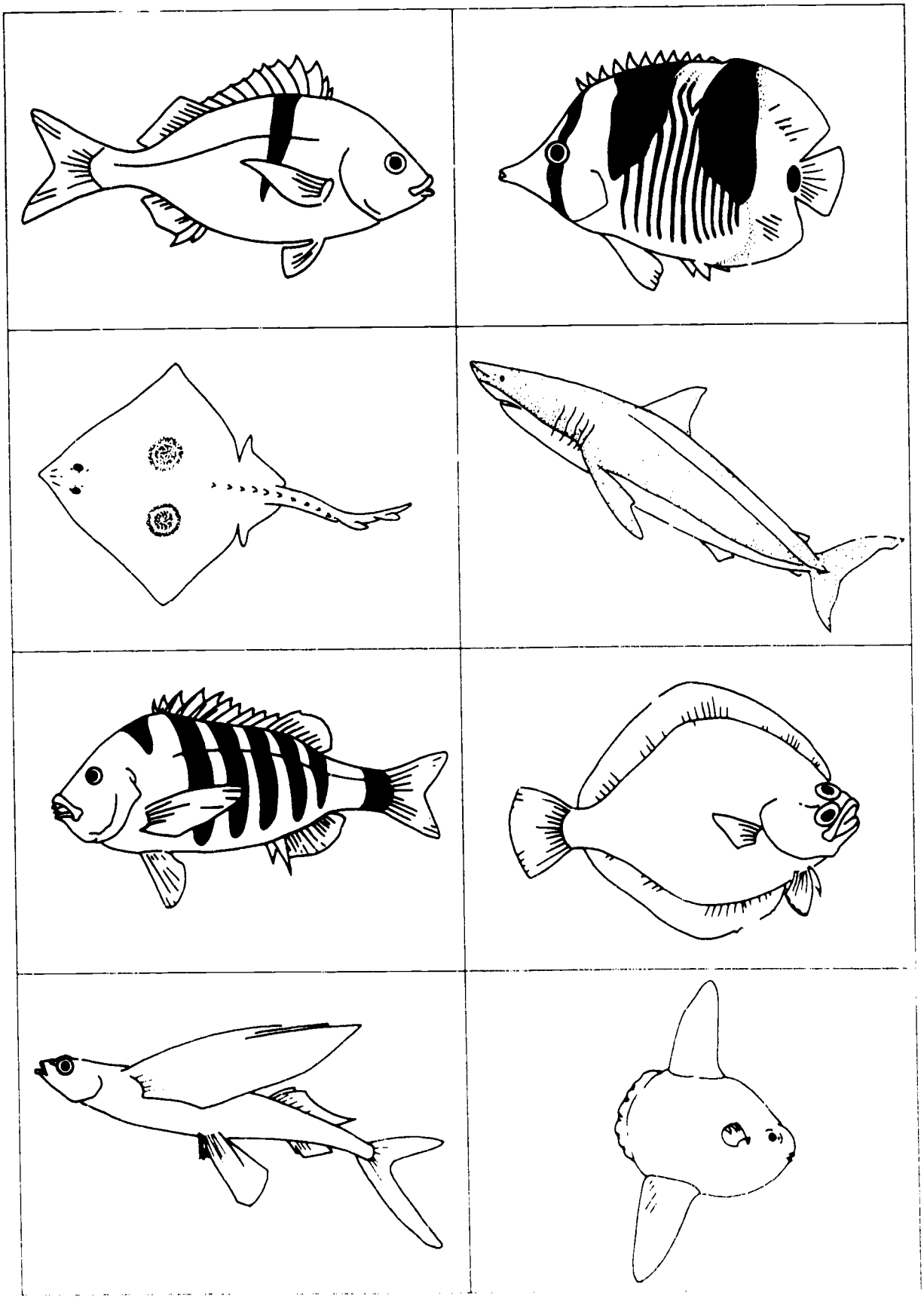
EXTENSION ACTIVITIES

- Research the life and theories of Charles Darwin, Carolus Linnaeus, H. B. D. Kettlewell, Charles Willson Peale, Jack Horner, J. William Schopf, Louis Leahy, Jean Baptiste deLamarck, Alfred Wallace
- Identify vestigial structures--remnants of an organism's evolutionary past that has no present function. For example, appendix in Homo Sapiens









INVITATION 3

Characteristics For Survival

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- **Sometimes the differences give individuals an advantage in surviving and reproducing.**
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

BACKGROUND

Survival is often correlated to an organism's ability to adapt to its environment. There are various body traits that can be identified as well as various ways species behave. Natural selection takes place when organisms of a species survive and reproduce. This produces organisms that are better adapted to their environment. It usually takes a long time for change to happen through natural selection. Charles Darwin was one of the first people to develop the idea of natural selection. This activity is designed to discuss ways organisms adapt to protect themselves.

MATERIALS

- one animal picture for each student. Try to have an even number of animals with shells, skin, feathers, fur, color, and patterns or enlarge pictures on pages 14-18.
- six pieces of ribbon and paper clips
- set of labels page 13

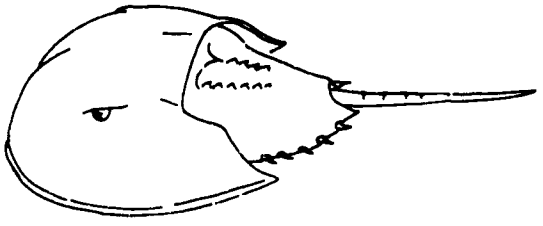
PROCEDURE

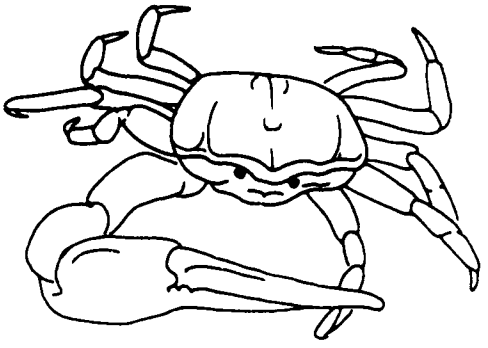
1. Staple a ribbon to each label. Display on wall or on board.
2. Distribute animal pictures randomly to the students. Have the students attach their animal to the category that is most important for that animal's survival. Most animals belong in more than one category. Birds have feathers that enable them to fly away from predators, and the color of the feathers camouflage birds in certain environments.
3. Divide the class into 6 groups. Give one ribbon of pictures to each group of students.
4. Invite each group to discuss the characteristics of their set of animals that increase the animals chance of survival.
5. Encourage students to find pictures of other animals for their category.
6. In journals reflect on the following questions: How do coverings protect animals? How do colors and patterns protect animals? What additional ways do animals have to defend themselves? What do Homo Sapiens do to survive?

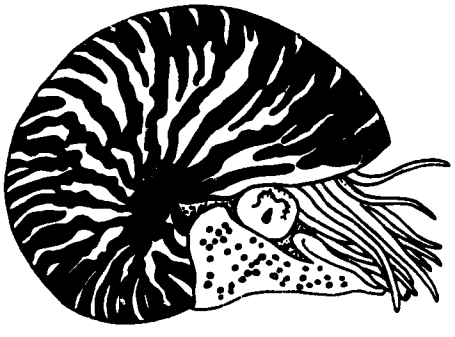
EXTENSION ACTIVITIES

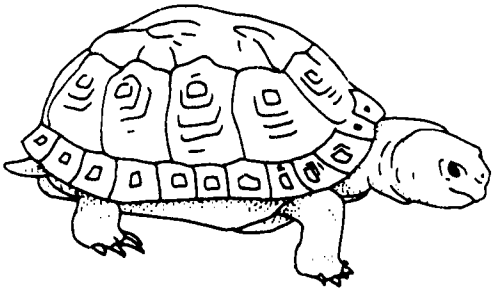
- Using drawing paper and crayons, draw and cut out an animal that uses camouflage. Draw the habitat for your animal. Draw another animal that is significantly different. Place both animals in the habitat and discuss your observations.
- Write a story about either a real or imaginary animal where camouflage and habitat play an important part.

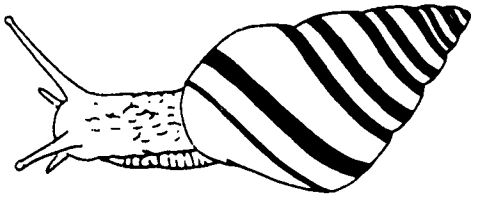
Shells Conchas
Skin Epidermis
Fur Piel del animal
Color Color
Pattern Patrón
Feathers Plumas

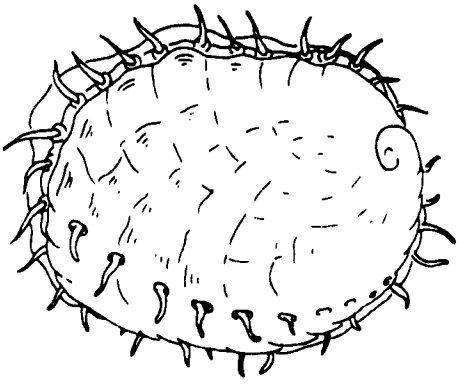


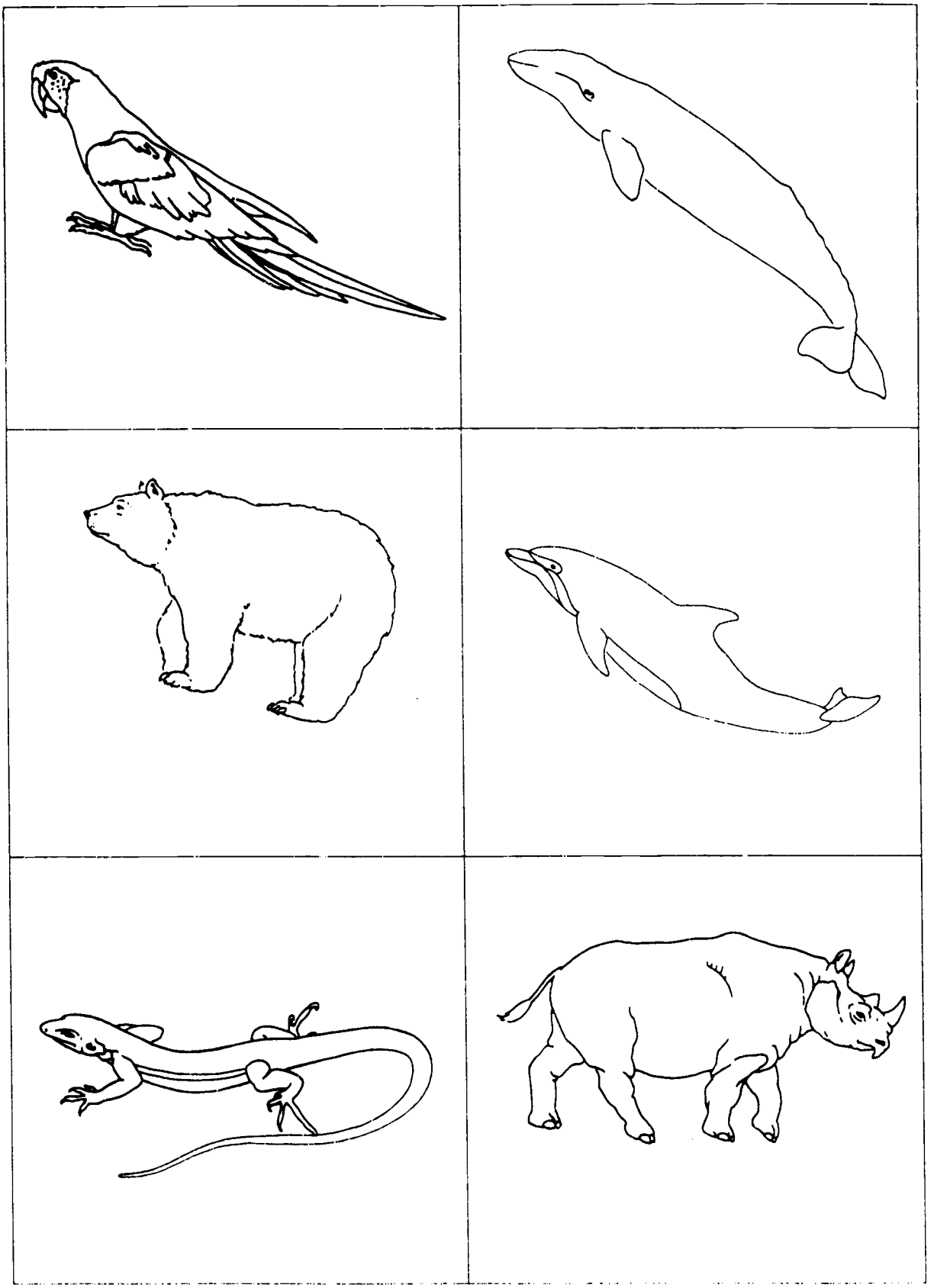


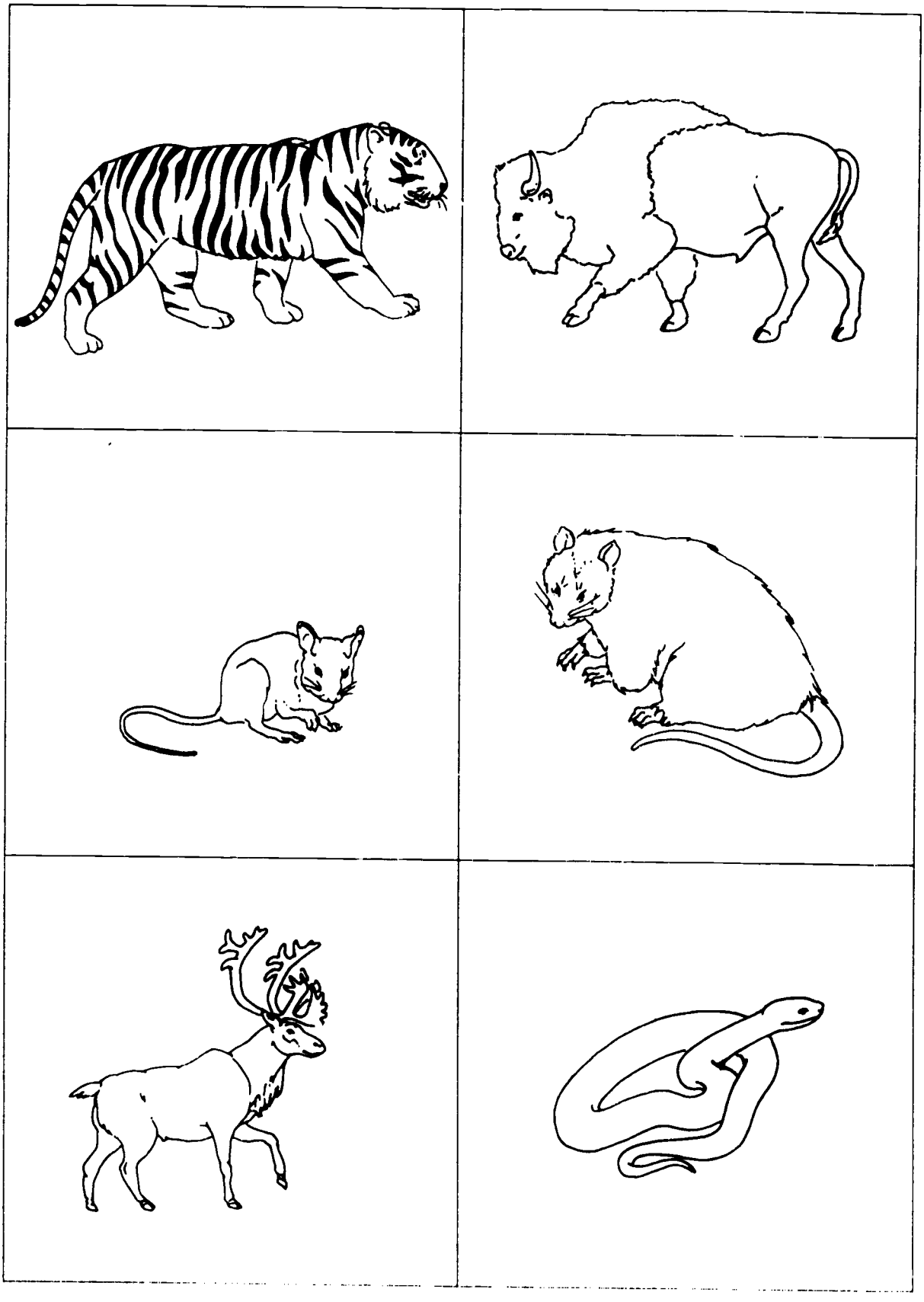


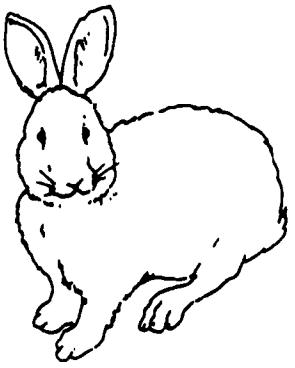


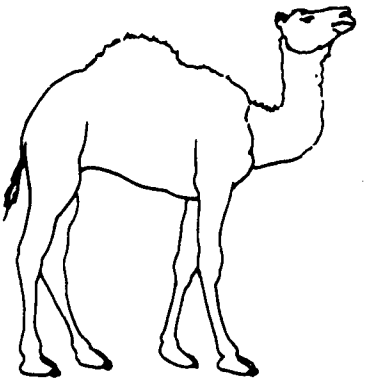


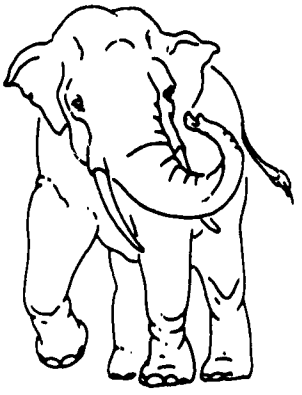


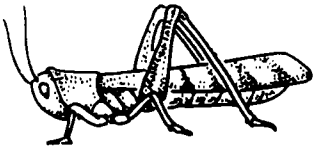


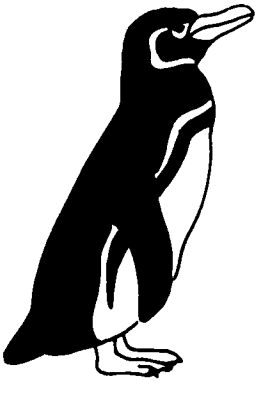


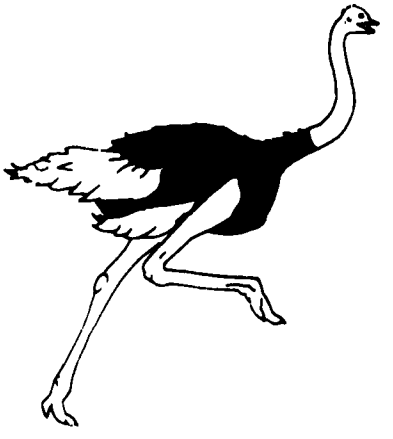


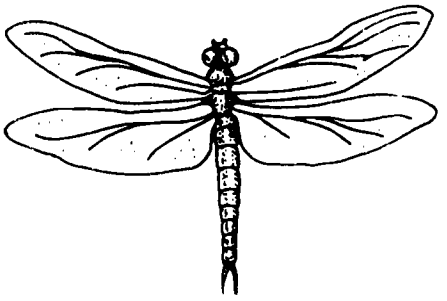


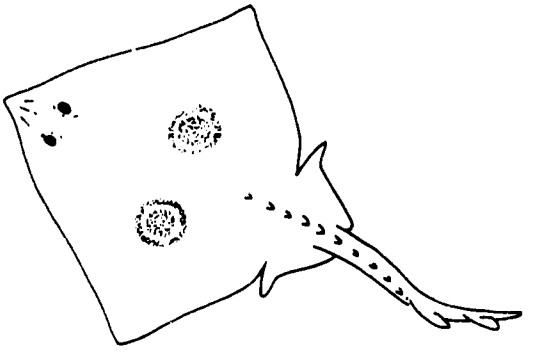


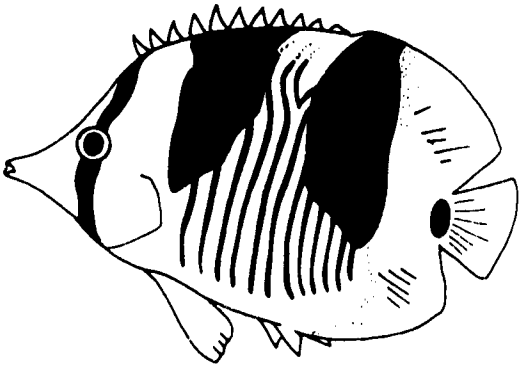


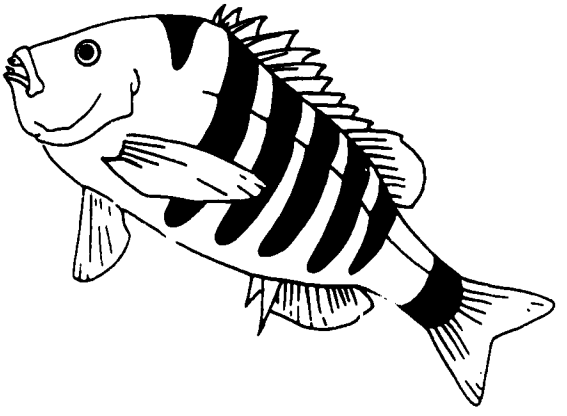


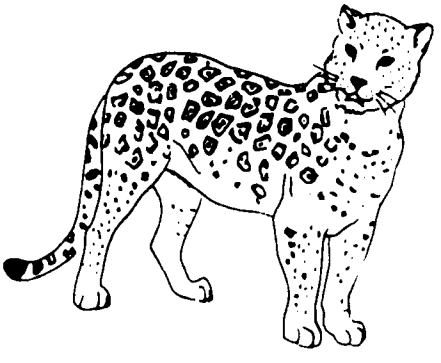


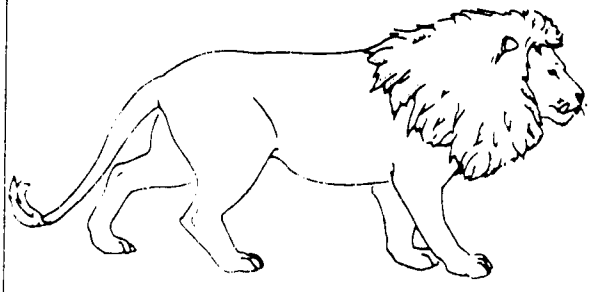












INVITATION 4

Hide And Seek

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- **Sometimes the differences give individuals an advantage in surviving and reproducing.**
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

BACKGROUND

Adaptations are traits of organisms that make living things able to survive in a given environment. For example, the insect called the walking stick looks very much like the twig that it sits on. The white of the polar bears' fur helps hide the polar bear in the snow.

Natural selection is the process by which something determines whether a living thing will survive to have offspring. In natural selection something in nature changes. For example, some chemical causes the color of the soil to change color. The organisms that were the color of the original soil become more obvious to predators. Gradually the organisms that are the color of the new soil survive to produce offspring, while the organisms that were the original color become more and more scarce.

MATERIALS

- arts and crafts supplies

PROCEDURE

1. Have students create a 3-dimensional creature that is approximately 2 inches by 2 inches by 2 inches. NOTE: It is important that all creatures be about the same size. The creature can be real or imaginary. Color the creature in such a way that it can be placed in the room without being seen, while at the same time being totally visible.
2. Have students "hide" creatures. Creatures cannot be under, in, or behind anything. Creatures need to be in "full" view.
3. Give students time to find as many creatures as they can without touching or pointing to them. Have students jot down on a piece of paper, what they saw and where they saw it. Encourage students not to share their findings.
4. Prepare a large two column chart.
5. One at a time have each student reclaim their own creature and tape it in the left-hand column of the chart. As each creature is placed on the graph, find out with a show of hands how many students saw that creature. Record number on the chart. Give students creating the best camouflaged creature a certificate of survival.
6. Divide room in half. Divide class into 2 groups, A & B.
7. Have students create another creature. Have each student hide their creature in their half of the room. Creatures cannot be under, in, or behind anything. Creatures need to be in "full" view.
8. Give class a limited amount of time, one minute, for example. NOTE: The time

may have to be adjusted so that some of the creatures will be found, but not all of the creatures. Students in group A look for creatures in group B's half of the room and vice versa. Have students collect creatures. When time is called, students should sit down and count the number of creatures captured by their group.

9. Give students whose creatures are still "alive" at the end of the time, Certificates of Survival.
10. Discuss the differences between the creatures that survived and the creatures that were captured.

EXTENSION ACTIVITIES

- Make a diorama using a shoe box or similar box. Design a habitat. Put three-dimensional animals in the habitat. See how many animals your friends can find.
- Make your own "How many animals can you find in this picture."

Certificate of Survival

for outstanding design of a creature that can survive in a given environment

Awarded To

_____

_____ _____

Signature *Date*

Certificatado de Supervivencia

por el magnifico diseño de una criatura que puede sobrevivir en un ambiente dado

Otorgado a

_____

Firma *Fecha*

INVITATION 5

Fossil Models

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- **Fossils can be compared to one another and to living organisms according to their similarities and differences.**
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

BACKGROUND

Most fossils are formed when organisms die and sink to the bottom of a body of water. They are then covered up by mud, sand, or clay. The matter that settles is called sediment. The weight of the upper levels of sediment changes the layers below into rock. There are two types of fossils: molds and casts. Molds are the hollow shapes left in the rock when an organism decays. Casts are molds that have filled with sediment and have hardened.

MATERIALS

- clay balls (2-4 cm thick)
- variety of small objects, natural or plastic
- cooking oil
- small milk cartons
- scissors
- water
- spoon
- plaster of Paris
- variety of leaves
- leaf identification books
- Optional: "Real" fossils (available from science supply stores.)

PROCEDURE

1. Have students roll a piece of clay out flat and press an object into the clay. Remove the object.
2. Number the molds and place them on the table. Have students record what they think the objects are by observing the molds. Save this list. Encourage students not to share their lists.
3. Have students retrieve their molds and coat the inside of the shape with a thin layer of cooking oil.
4. Carefully pour the plaster into the clay molds. Set the mold aside and let the plaster harden overnight.
5. When hardened, gently remove the plaster casts from the clay.
6. Number the casts and place on the table. Have students record what the objects are by observing the casts.
7. In small groups, compare results. Discuss areas of disagreement.
8. Explain how the process used to make molds is similar to the way fossils are formed on earth.
9. Have each student make a mold of a leaf. When the mold has been made, have

students hide the leaf they used to make the mold.

10. Number the molds. Have a large variety of other leaves similar to ones used to make molds, but not the identical leaves. Have students try to determine what kind of leaf might have been used to make the mold.

QUESTIONS FOR DISCUSSION OR JOURNAL REFLECTION

- Was it easier to identify molds or casts? Why?
- If the imprint of an object was deeper in the clay than the others, what can you infer about the object?

EXTENSION ACTIVITIES

- Compare "real" fossils to the leaf molds.
- Take a field trip to a museum or nature center that has fossils.
- If you live in a part of the country where fossils can be seen in their natural state, take a field trip to that area.

INVITATION 6

Digging Fossils

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- **Fossils can be compared to one another and to living organisms according to their similarities and differences.**
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

BACKGROUND

A fossil is the actual remains of an organism that lived some time in the past. Fossils provide evidence of organic evolution. Fossils are formed in many ways. some trees produce a sticky, gum-like resin that hardens into a transparent yellow substance called amber. Some insects became trapped in the amber and were preserved. In order to keep from destroying fossils, scientists must dig very carefully. NOTE: This activity needs teacher preparation time before the "dig."

MATERIALS

- dirt, sand
- leaves
- shells
- bones
- plastic dish pan for each group
- the smallest plastic spoons you can locate i.e. ice cream sample spoons
- tooth picks
- small paint brushes
- plastic insects
- colorless, hard-drying, waterproof glue

PROCEDURE

1. Before the "dig," prepare dish pan "dig" sites. Make a dishpan set-up for each group of students.
2. Use leaf molds from Invitation 5 or make several small plaster of Paris leaf molds for each site. They do not need to be perfect or complete leaves. Make "amber bugs." Put plastic insects in glue. Let dry until hard.
3. In each pan, layer dirt and sand. Hide bones, shells, leaf molds, and amber bugs in layers. Each pan should have the same number and kinds of items. Cover with water and let dry out for a few days.
4. Give each group of students a dishpan "dig." Have students dig out the "fossils" from the site using only small plastic spoons, paint brushes and toothpicks. Encourage students to be very careful so no fossils will be destroyed.
5. In journals, have students reflect on: Why are fossils found deep in the earth? What can we learn from digging for fossils?

EXTENSION ACTIVITIES

- Have students write a story about the items they "dug" up.

INVITATION 7

Bones, Bones, And More Bones

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- **Fossils can be compared to one another and to living organisms according to their similarities and differences.**
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

BACKGROUND

NOTE: This activity requires some teacher preparation time several days before the activity is to be done. Invite some parents to help prepare chicken bones.

MATERIALS

- bones of a chicken for each group
- clay

PROCEDURE

Before the day for this activity prepare bones. Boil the chicken in water until the meat can be removed easily. Soak bones in a bowl with bleach for several minutes. Drain and dry them.

1. Give each group of students a set of bones, but do not tell them that they are chicken bones.
2. Tell students that they are paleontologists and have found these bones. Invite students to assemble the bones into some reasonable animal using all of the bones. They can hold the bones together with small pieces of clay.
3. Have students draw a picture of what this animal might look like?
4. Compare drawings with other classmates.
5. For older students, you may want to mix the bones up and not include all the bones of one chicken in a group's bag.
6. Have students reflect in their journals on how their experience with trying to assemble the bones is similar to the way paleontologists have assembled dinosaurs. What bones were the easiest to identify? Why?

EXTENSION ACTIVITIES

- Go to a natural history museum where there are bones on display.
- Invite a taxidermist to bring bones from different animals. What bones are similar, which ones are different? How can you tell which bones go with which animals?

INVITATION 8

Then And Now

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- **Some organisms that lived long ago are similar to existing organisms, but some are quite different.**

BACKGROUND

By studying rocks and fossils, scientists are presently dividing geologic time into four major eras: Pre-Cambrian, Paleozoic, Mesozoic, and Cenozoic. Precambrian time covers almost 9/10 of earth's history. It is almost impossible to grasp concepts like 500 million years ago. It is not necessary for students to memorize names of eras periods or epochs, although some of the names may become familiar with use. Students probably already have a sense of the Jurassic period.

Organism is used to refer to both plants and animals however large or small.

MATERIALS

- enlarged pictures from pages 30-33
- yarn of different colors
- very long ribbon or tape
- arts and crafts supplies

PROCEDURE

1. Starting at the door, attach a ribbon around the room using three walls. Tell the students that outside the door is the Pre-Cambrian period. Each of the other three walls represents the Paleozoic, Mesozoic, and Cenozoic.
2. Divide each wall into periods and epochs with vertical ribbons. See the chart on page 34.
3. Enlarge each of the pictures on pages 30-33. Have students randomly select one picture. Invite students to research the organism selected. Color and mount pictures. Invite students to attach the assigned organism to the approximate time period. ALTERNATIVE: Instead of enlarging pictures, give students the pictures and invite them to draw a larger version or create a three dimensional model of the organism.
4. Invite students to research the descendants and ancestors of the organism they were assigned. Don't forget to include plants.
5. Connect ancestors to descendants using colored yarn.
6. Invite students to select an organism they know exists today. Find a picture or draw a picture of that organism. Attach the pictures to the end of the time line. Using yarn, connect organism to its ancestry.
7. Invite students to select an organism that they know has become extinct. Draw a picture of that organism and find its ancestry. Attach pictures to the time line at the approximate time of extinction.

Connect to ancestry with yarn. Label all the organisms on the entire time line that have become extinct.

8. In journals, reflect on the following question: Is extinction part of the natural process or should humans intervene by trying to save certain species?

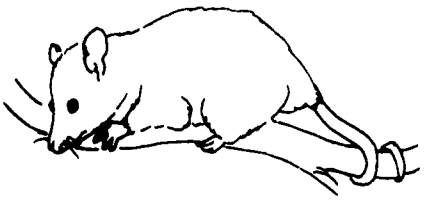
9. Have a panel debate on the question posed in question #8.

EXTENSION ACTIVITIES

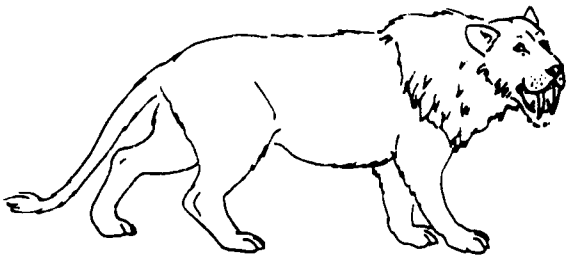
- Take a field trip to a Natural Science Museum.
- Watch the videocassette *Natural Selection,* Films for the Humanities and Sciences, P.O. Box 2053, Princeton, NJ 08543
- Take a field trip to a large super market. Identify the "new" fruits and vegetables that did not exist years ago. Instead of a field trip, the teacher or students can bring "new" fruits and vegetables to class. How were they created? Why were they created?

The following list is for the teacher. All representations of the animals are approximate. For example, there are many different types of mammoths, we have selected one. The plants represented here are also approximations. It is impossible to represent the thousands of variations of ferns that evolved over time. We offer these pictures as a starting place not as the last and definitive word. The following chart does not contain "right" answers. Evolution takes a very long time. We include it here only to help you launch your students into the approximate time period. Controversy is normal, scientists do not agree. Different resources do not agree. Engage your students in the debate.

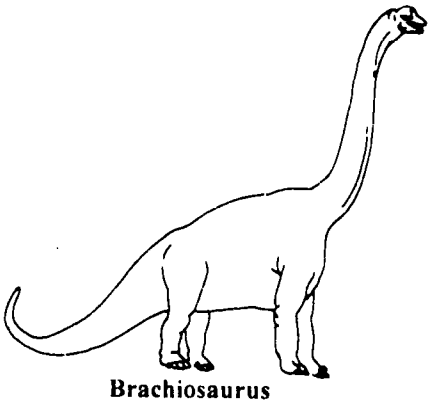
ORGANISM: Plant or Animal	**Approximate time of appearance**
Archelon	Upper Cretaceous
Bellerophon	Cambrian
Bennettitales	Jurassic
Bison	Pleistocene
Brachiosaurus	Late Jurassic
Brontotherium	Oligocene
Cladoselache	Devonian
Conifers	Jurassic
Coraitales	Carboniferous
Cycads	Cretaceous
Cynognathus	Triassic
Diatryma	Eocene
Endoceras	Mid-Ordovician
Eodelphis	Cretaceous
Equistes	Carboniferous
Eusthenopteron	Devonian
Gigantopithecus	Quaternary
Gingko	Jurassic
Hyracotherium	Eocene
Ichthyosaur	Jurassic
Mammuthus imperator	Recent
Megatherium	Pliocene
Nipa	Lower Eocene
Orthis	Cambrian-ordovician
Paradoxides	Middle Cambrian
Protodonata	Carboniferous
Smilodon	Oligocene
Sphenophyllum	Carboniferous
Stegosaurus	Jurassic
Tyrannosaurus	Cretaceous
Ursus Spelaeus	Miocene
Wolf	Pleistocene



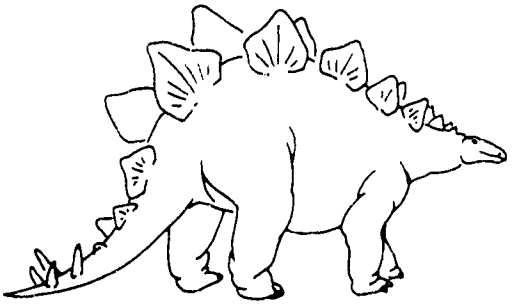
Eodelphis



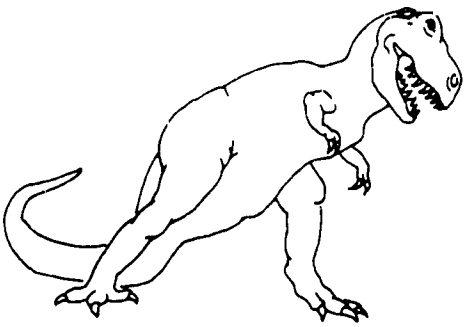
Smilodon



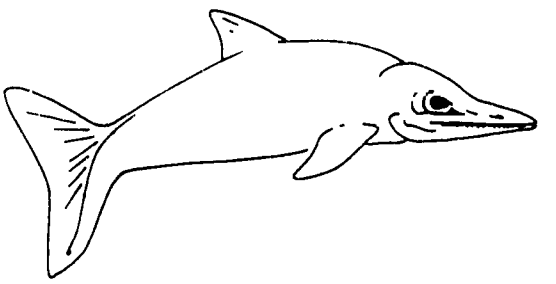
Brachiosaurus



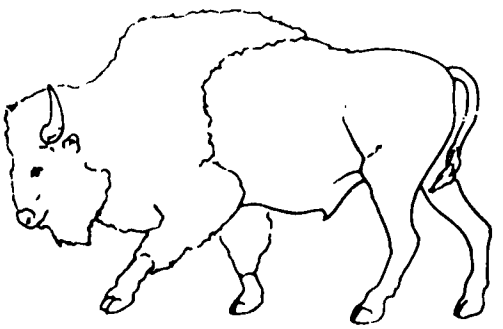
Stegosaurus



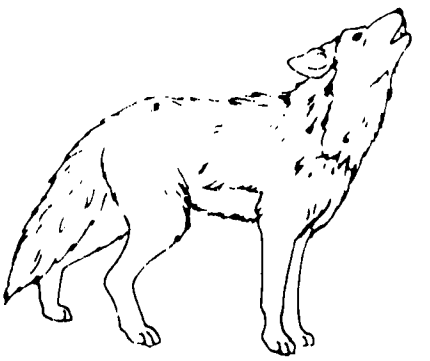
Tyrannosaurus



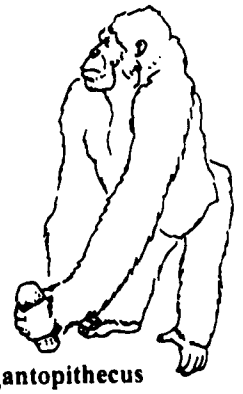
Ichthyosau



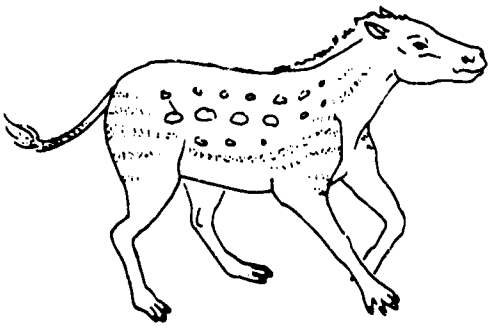
Bison



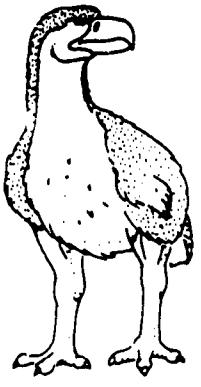
Wolf



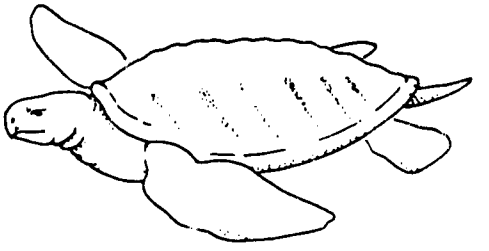
Gigantopithecus



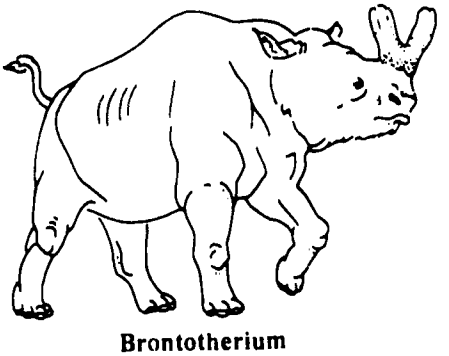
Hyracotherium



Diatryma

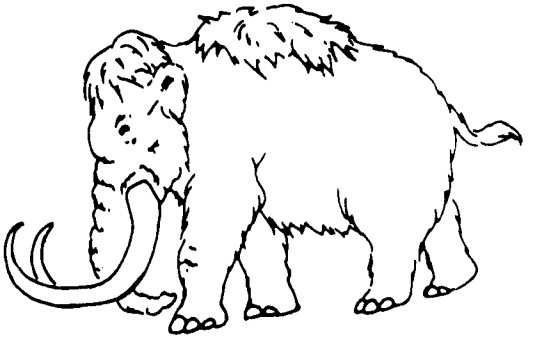


Archelon

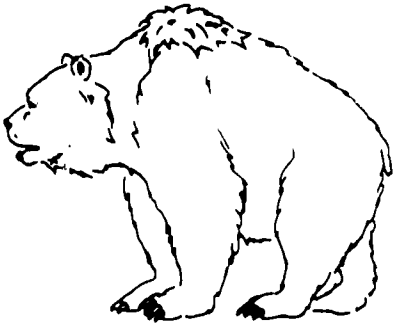


Brontotherium

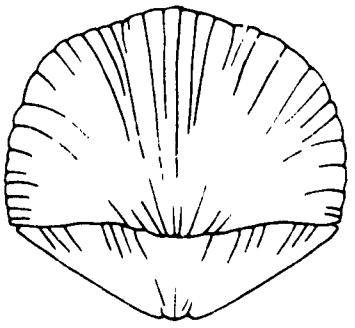
Megatherium



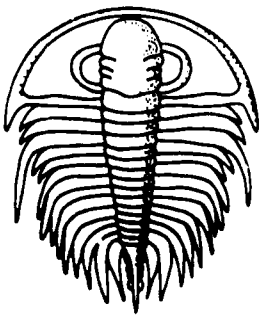
Mammuthus imperator



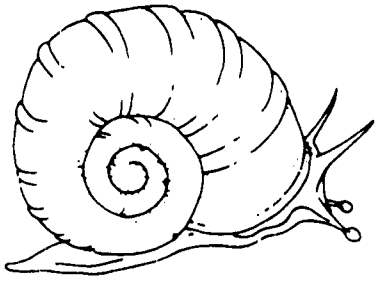
Ursus Spelaeus



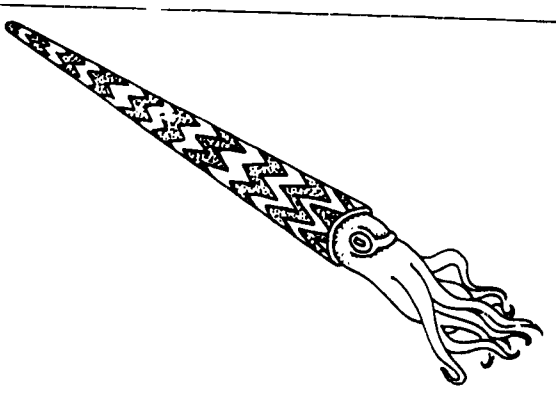
Orthis



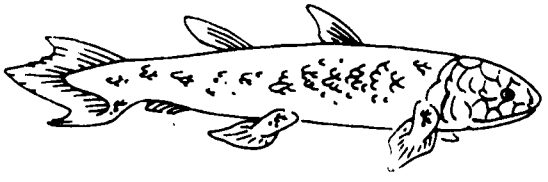
Paradoxides



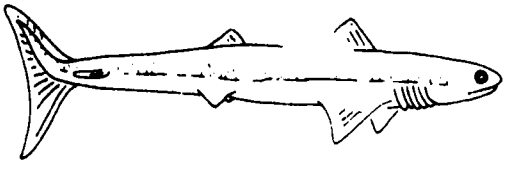
Bellerophon



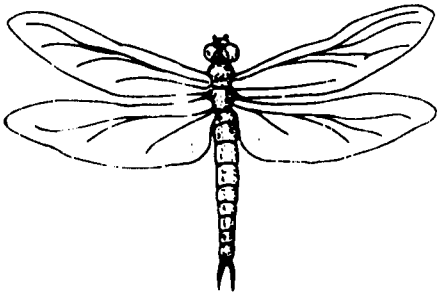
Endoceras



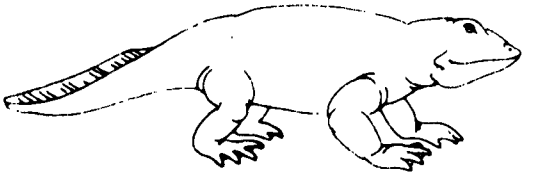
Eusthenopteron



Cladoselache



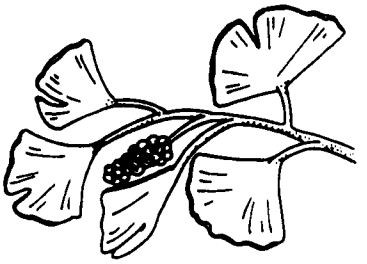
Protodonata



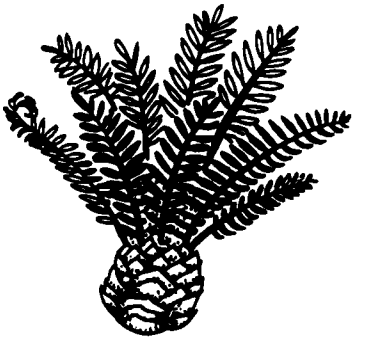
Cynognathus

Sphenophyllum

Bennettitales

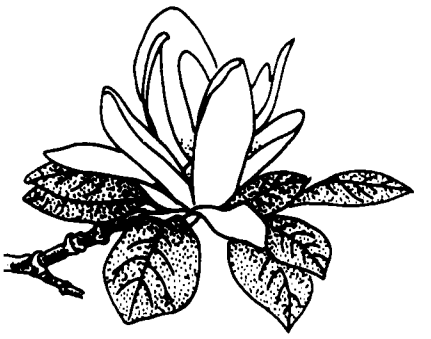


Gingko



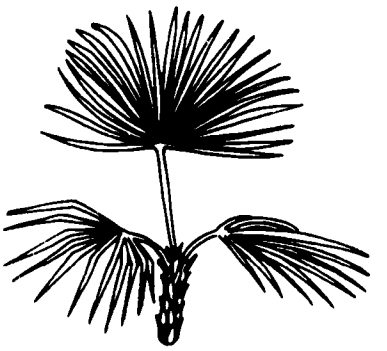
Cycads

Corditales



Magnoliaca

Conifers



Nipa

Era	Period	Epoch	Age (years ago)	Representative life forms
Cenozoic	Quaternary	Recent	100,000	Homo sapiens, modern plants and animals
		Pleistocene	1,000,000	Extinction of many mammals; primitive humans; grasslands
	Tertiary	Pliocene	10,000,000	Early humans, mammals, herbs
		Miocene	30,000,000	Mammals, grasses
		Oligocene	40,000,000	Primates, mammals, forests
		Eocene	60,000,000	Primitive horse, mammals, flowering plants
		Paleocene	75,000,000	Mammals, flowering plants
Mesozoic	Cretaceous		135,000,000	Extinction of giant reptiles; birds, insects, flowering plants
	Jurassic		165,000,000	Dinosaurs dominant; primitive birds and mammals; earliest flowering plants
	Triassic		205,000,000	Dinosaurs, reptiles, early mammals, primitive seed plants.
Paleozoic	Permian		230,000,000	Rise of insects; early reptiles
	Carboniferous		280,000,000	Insects and amphibians, mosses and ferns
	Devonian		325,000,000	Age of fishes, early amphibians, early bryophytes, ferns
	Silurian		360,000,000	Club mosses; insects, invertebrates
	Ordovician		425,000,000	Primitive mollusks, fish, algae
	Cambrian		500,000,000	Protists; sponges, jellyfish; spore producing plants
Precambrian			4,500,000,000	Monerans; simple protists; fungi, simple invertebrates

INVITATION 9

Where Did That Come From?

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- Some organisms that lived long ago are similar to existing organisms but some are quite different.

BACKGROUND

Carl Linnaeus, a naturalist in the late 18th century, believed that each species was distinct and unchanging. Jean Baptiste de Lamarck suggested that there were no limits that separated one species from another. He also suggested that if the environment of a species changed the species would adapt to the new environment. For example, he suggested that the giraffe's neck grew longer as the giraffe constantly had to reach higher and higher for food. Charles Darwin, proposed that under certain circumstances favorable variations would tend to be preserved and unfavorable ones would be destroyed. This led to the process known as "natural selection."

Throughout the history of humanity, people have tried to explain why certain organisms look a particular way. These stories have been preserved in folktales in all of earth's cultures.

MATERIALS

- Caduto, Michael, & Joseph Bruchac. *Keepers of the Animals*, "How the Butterflies Came to Be." Golden CO, Fulcrum Publishing, 1991.
- Julius Lester, *The Adventures of Brer Rabbit,* "How the Animals Came to Earth," "Why Brer Bear Has No Tail," New York: Dial Books, 1987.
- a variety of "creation stories" from many different cultures.

PROCEDURE

NOTE: Please read the Forward to Lester's book before beginning this activity.

1. In groups, invite students to select one creation folk tale that they would like to present to the class.
2. Invite students to prepare a skit that tells the story of creation from the myth's point of view.
3. Discuss the similarities and differences among the folk tales.
4. Read "Why Brer Bear Has No Tail" and "How the Butterflies Came To Be" aloud to the class.
5. Invite students to select an organism and write a folktale to explain why the organism has some characteristic or trait.
6. Collate stories in a book and publish the book.

INVITATION 10

Time Travel

CONCEPTS

- Individuals of the same kind differ in their characteristics.
- Sometimes the differences give individuals an advantage in surviving and reproducing.
- Fossils can be compared to one another and to living organisms according to their similarities and differences.
- Some organisms that lived long ago are similar to existing organisms, but some are quite different.

MATERIALS

- arts and crafts supplies
- copy of videocassette *Jurassic Park*
- *The Real Jurassic Park*, video available from NOVA

PROCEDURE

Preview video several times. Identify statements or scenes that are based on present scientific theory or sound or look as if they are based on scientific theory.

1. Have students research the Jurassic period identifying organisms that were in existence during that time.
2. Watch the video *Jurassic Park*. While watching the video invite students to raise hands when a statement is made or a scene is shown that either is accurate or not accurate according to present scientific theory. When a statement or scene is identified, stop the tape. List statement or scene on a list labeled "Based on scientific theory", "Not based on scientific theory", "Not sure."
3. You do not need to watch the whole video. Fast forward or skip to scenes and statements that students may identify.
4. Discuss the lists until all students are reasonably sure that the lists are as accurate as possible. For items in "Not Sure" help students clarify the issues involved.
5. Compare information on video *The Real Jurassic Park* from NOVA with the list created in #4.
6. Have students research the Triassic period. Create a Triassic Park in the classroom. Encourage students to create a park that more nearly represents what is presently known to be true about that period.
7. Have students reflect in their journals on the difference between information that is probably true given what we *know* at the moment and information that is pure fiction.
8. Invite other classes or parents to the *Park*.

EXTENSION ACTIVITIES

- Read other works of science fiction.
- Write a science fiction story.

MY

SCIENCE

JOURNAL

Scientist's Name_____

MI

CUADERNO

DE

CIENCIA

Nombre del Científico_____

Journal Thoughts and Ideas

Invitation_____

Books I've read on this topic

Today I learned

Cuaderno de Ideas
Sugerencias_____

Libros que he leído sobre este tema.

Aprendí hoy . .